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PLANNING AND MONITORING PRODUCTIVITY:  
- LINKING STRATEGY AND OPERATIONS

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## I INTRODUCTION

Labor productivity has become a salient concern in the United States, as the measured rate of productivity growth has declined - both in absolute terms and relative to rates being attained by major trading partners.

Staats [34], formerly Comptroller General of the United States, specifies the decline in the growth rate of U.S. productivity as one of the major issues currently facing the country.

Malkiel [25] analyses the economic and social factors which may underlie the phenomenon. He identifies several contributory factors, although he notes that the information and analytical methods by which to quantify the impact of each is not available. First, he draws attention to the changing composition of the U.S. workforce, towards a higher proportion of younger and less-experienced workers. Next, he points to the diminishing role of fixed capital formation, attributing this to two factors: first, to the high rate of inflation, which may have created levels of uncertainty inimical to the process of investing in long-lived assets; and secondly, to the demand for investment funds created by the need to comply with social legislation in areas such as safety and pollution control, which may have displaced investment which would otherwise have expanded output and increased productivity directly.

Malkiel also discusses the possible effects of surging energy prices, suggesting these may have engendered a switch from energy-intensive to labor-intensive methods of production. Jorgenson (in Flint [17]) expresses a similar hypothesis, but in a more direct fashion. He claims that the use of fixed assets is in general more energy-intensive than the use of labor. In the absence, presumably, of instantaneous adjustment of expected prices

of fixed assets and labor relative to energy, this would result in a tilt in the capital-labor cost curve in favor of labor substitution. If true, the adjustment process of substituting labor for capital would tend to result (all else being equal) in a decline in the measured level of output per unit of labor input. In addition, it seems probable that increased energy prices would lead directly to capital investment aimed simply at energy conservation, thereby displacing output-expanding and productivity-improving investment. For example, Hatsopoulos et al. [23] identify a number of areas in which manufacturing industry, using currently-available technology, could invest to achieve significant reduction in energy usage. They justify such investment solely in terms of savings in energy costs, implying that other factor inputs, such as labor, would be largely unaffected. Thus, it is conceivable that escalating energy prices could have caused substantial capital investment, with little effect on labor productivity.<sup>1</sup>

Finally, Malkiel notes the lagging rate of investment in research and development, which is likely to have caused a decline in the technological quality of investment in products and production methods.

Both Staats and Malkiel call for combined industry-government action to address and seek solutions to the problem of declining productivity growth.

There are however two issues to be resolved, at least in some degree, before a joint industry-government approach might have some modest chance of success. In the first place, it is by no means clear that the dominant goals of government and industry, with regard to productivity, are, or even should be, closely aligned. A government's economic concern, it might be suggested, should be focused on preserving the highest possible level of real return, and stability through time of that return, to the working populace. Industry's concern, on the other hand, should be focused on preserving in real terms the level and stability of the returns to financial

capital - otherwise, the legitimacy of the private sector as a vehicle for investment in society would deserve to be challenged. This is not to say that both parties do not share a common concern for both labor and capital productivity. But the means-end schema for each is likely to be - and properly so in a democratic, free-enterprise social order - inverted.<sup>2</sup>

And in the second place, even if there were a unique congruence of the goal sets of the two parties, there would still remain a very considerable confusion as to the relevant information which might enter into a constructive dialogue about the productivity problem. As pointed out by Dogramaci [14], and by Fabricant [15], there is considerable, and largely unresolved, debate about how productivity should be defined and measured. Further, even within a consistent definition of the term and use of a specific measurement technique, the reliability of the statistics produced from one situation to another, and between different time periods, is generally in some doubt. Worse yet, the process of developing a causal explanation of measured changes in productivity over time - an essential ingredient to any dialogue aimed at designing changes which will enhance productivity growth - verges on the intractable.

In other words, even though it is generally accepted that productivity growth is declining, and that the decline poses a serious problem for the U.S. economy, it is salutary to bear in mind that productivity, at the macro-level, is not something which can be unequivocally defined, measured, or changes in its levels easily explained.

## II SCHEME OF THE PAPER

Despite the caveat expressed at the end of the preceding section, it seems reasonable to suppose that productivity does indeed pose a problem, when viewed in the context of the economic aspirations of U.S. society. The focus of the paper is directed to the micro level, that is to say, to the

level of the individual firm. It is at this level that the main decisions are made which ultimately reflect in the macro situation. Even if the measurement and analysis of productivity at the macro level give the appearance of being intractable, this need not be the case at the level of the firm. Indeed, were it so, it would raise a serious question as to the feasibility of purposive management of the firm.

The paper's main thrust is the development of a general framework, with accompanying procedures and sequencing of analysis, by which to manage productivity. This, however, cannot be done without considering productivity comprehensively within the realm of a firm's goal structure and performance.

The discussion begins with a brief review of the formal corporate planning literature. Corporate planning, at least as represented by the literature, has not dealt with a firm's internal process of transforming inputs to outputs, in other than an indirect manner. In order to deal with productivity as a matter of strategic concern, it is proposed that the content of corporate planning has to be expanded to include explicit consideration of this aspect of a firm's activities.

The managerial literature on productivity is then considered. Management of the capital-asset/labor mix is identified as a central focus for corporate planning directed to the issue of productivity. A middle-range planning framework is synthesized from the literature, proposing an integration of product-market strategies, technological forecasting and human-resource strategies around the definition of production strategies expressed in terms of capital-asset versus labor intensiveness.

In operationalizing the framework, a decomposition of the planning process into four stages is suggested, as follows: (1) definition of future feasible configurations of production systems; (2) their economic assessment under deterministic assumptions, (3) their economic assessment under conditions of uncertainty; and (4) a socio-political assessment, with a view to developing enabling strategies in cases where radical change in production technology is contemplated.

Next, the problem is addressed of translating planning output from the framework into financial projections of the firm's performance. The general features of a financial simulation model, suitable for tracing the aggregate financial-performance consequences of current and considered production strategies, are described and discussed.

This leads to consideration of the development of relevant data, pertaining to the costing of capital assets and labor, and to substitution between these two resource categories.

Implications arising from the analysis for accounting systems are briefly dealt with, from two interdependent perspectives: (1) the extraction from an accounting data base of cost parameters to support the proposed planning; and (2), the development of performance-tracking systems to monitor and explain movements in productivity, and to reinforce in a delegated mode strategies which have been adopted in the corporate planning process.

### III CORPORATE PLANNING AND PRODUCTIVITY

During the past 15 years or so, following Anthony [4], much of the literature on managerial planning and control has been written from a

process perspective. A dominant focus has been the design of administrative structures, procedures and information systems to manage an organizational process, that process being characterized in terms of a typology of decisions ranging from strategic to operational. This approach has not concerned itself directly with the content of decision making.

More recently considerable interest has emerged with regard to the content question. This has largely adopted a product-market focus as the dominant rationale for the articulation of a corporate business strategy. The approach stems from some early work supported by the General Electric Company (GE), subsequently generalized by the Marketing Science Institute through their Profit Impact of Market Strategies (PIMS) project (Buzzell, et al. [7]). Briefly, the PIMS project claims a positive association between a product's market share and the return produced on the investment to support its design, manufacture, distribution and sale. With a number of refinements (see Allan [1]), the PIMS hypotheses were adopted and popularized by the Boston Consulting Group (BCG). The BCG framework provides a method and format for representing a company's products in a matrix. Based on the notion of a product life-cycle, the framework combines growth rate with market share (measured relative to the share of principal competitors) to arrive at a strategic partitioning of a company's product-market segments. Prescriptions are then derived, essentially judgmentally, for the cash flow and profitability pattern which management should expect, or aim for, from each segment. Strategically, the issue, in



a sequential sense, reduces to one of selecting a product-market portfolio to produce an expected pattern of financial flows, measured in terms of growth, rates of return, and variability, from the firm's total businesses.

There is also a wide body of literature on corporate financial strategy.<sup>3</sup> This literature begins from the opposite end of the factor-market spectrum. It essentially assumes that the financial market is the ultimate determinant of the firm's business strategies. Available to corporate management, according to the theory, is a financial specification of the investment (and production) opportunity set facing the firm; also available is a specification of the financing opportunities provided by the financial markets. The problem reduces to one of choosing a portfolio of investments and their financing which efficiently balances the risk-return tradeoff to the firm's owners. In this context, it is important to note that the portfolio referred to in financial management theory is not precisely analogous to the portfolio referred to in the product-market analysis of corporate business strategy. Financial management theory adopts the notion of a Markowitz portfolio which was formulated to provide an efficient choice from among a set of financial assets. In Markowitz' theory, the financial assets, which comprise the opportunity set for investment, must be separate from one another, so that the covariances among the expected financial flows arising from assets have a defined status in the syntax of the theory. It is a matter for conjecture whether these separability conditions are usually met in respect to a set of investment proposals generated within a company. Certainly, it seems to suggest a greater divisibility of production functions within the firm than experience would deem plausible.

Neither the product-market analysis, nor the normative financial management approach, addresses the intervening logic linking product-market and financial-market opportunities. Both essentially assume away the problems of constructing feasible production functions, and choosing from among them. Without belittling the contribution which each theory has made to the content of corporate strategy decisions, it seems clear that they have both avoided the complex heart of the matter.

However, the PIMS project has investigated the underlying forces which may explain a positive relationship between market share and profitability (Buzzell, et al. [7], Schoeffler [32], [33]). There are several factors which seem plausible in this regard, but chief among them is the experience curve. Certainly the experience curve is pivotal in the BCG framework (Allan [2]). In brief, the experience curve is fitted from an empirical relationship between the average unit cost of a product and its cumulative production volume over time. Average unit cost is observed to decline by a fixed percentage - the value of the percentage depending on the characteristics of a particular product - every time the cumulative output volume of the product doubles. In competitive terms, then, a company maintaining a higher market share for a product will have a higher cumulative volume of output at any point in time than its competitors. It should, therefore, in accordance with the logic of the experience curve, enjoy an enduring, although declining, cost advantage. This cost advantage can be translated, through managerial policy, into greater pricing flexibility, higher margins, greater re-investment in product or market development, higher return to investment, or a combination of all these.

The experience curve is an empirical phenomenon which has been observed from historical statistics to hold for long periods of time and in various industries. It has been formally vested with a prospective status by, for

example, its requirement in Government contracting, in cases where contracts will require a long-term commitment to sourcing and supply. It is a common assumption in the practice of managerial control, whereby real efficiency gains are assumed in the setting of cost standards, without necessarily identifying specific sources of the gains. And, it is assumed when the PIMS/BCG framework is used in a prescriptive, as opposed to descriptive, fashion. Despite this, there is no explanatory underpinning to the phenomenon on which to base the design of managerial planning systems.

In the literature of corporate planning, the production and distribution<sup>4</sup> functions all but disappear from explicit consideration. It would seem that these are viewed as being delegated to some lower level of the managerial hierarchy, presumed to be determined by corporate-level decisions on product-market and financial-market strategies. For instance, Vancil and Lorange [37] in their prescriptions about the sequencing and content of strategic planning systems, exclude the setting of functional strategic objectives from their schema. On the other hand, Ansoff [3], in a review of the historical development of planning systems, draws attention to the emergence during the 1970's of "capability planning" within the realm of corporate planning. It seems reasonable to interpret Ansoff's term as an activity leading to an articulated set of functional strategies aimed at creating or maintaining a critical set of capabilities in an organization, capabilities central to the organization's capacity for defining and carrying out work.

Many leading companies have recently appointed senior executives to focus specifically on productivity (Murray [28]). This organizational response to the issue is in line with Starr's [35] recommendation. For many years Starr has been warning U.S. managements of the unfavorable consequences of slighting production in the corporate strategic planning

process. Nevertheless, it remains an important empirical question as to what exactly these senior executives responsible for productivity do, what information is generated for their use, and what influence they exert in the strategic planning and resource allocation processes.

Gallese [19], in an article on productivity and employment, makes the point that in the past few years U.S. business has been substituting labor for capital. He goes on to observe that, ". . . companies themselves often aren't clearly aware of the labor-capital substitution because it takes place gradually and frequently reflects dozens of day-to-day decisions by shirt-sleeve managers on the factory floor. And in many cases even substitution resulting from major corporate decisions occurs not so much from a deliberate plan to make the switch as from evolutionary developments in a company's business" (pp. 1 and 11). These comments reinforce the suggestion that productivity is not an area of performance which has been either planned for or monitored in an explicit way in companies' strategic management processes.

Indeed, there are two disparate emphases in the managerial literature on productivity. The predominant one, in terms of the volume of writing, addresses the matter from the standpoint of eliciting incremental improvements in productivity, within the broad configuration of a firm's current production system. This approach focusses on human beings characterised as workers and operational problem solvers as the source of productivity. Hinrichs [24] presents an excellent collection of case studies demonstrating the improvements which can be attained by more effective use of human resources. However worthwhile, this approach is essentially partial in its orientation.

Other authors stress the role of fixed capital formation in the improvement of productivity (e.g, Thurow [36]). It seems clear that

significant, as opposed to incremental, improvements in productivity must rely on capital investment as a principal causal factor. But the application of relatively greater amounts of financial capital, without an attendant progress in the technical quality of the investment, is ultimately self-defeating as a path to sustained productivity improvement.

A few authors (e.g., Starr [35], Gold [20], [21]) propose a holistic, systems approach to the issue. This begins from a central precept that productivity is designed into a production system, rather than being incrementally elicited at the margin. It does not displace the on-going, tactical efforts to attain productivity improvements. But it does suggest a re-direction of these within a comprehensive framework and planning process, conducted at the top-management level of a firm. Moreover, the planning component should be relatively unconstrained, at least initially, by the traditions and current experience of the firm. It is this viewpoint which provides the basis for the remainder of the paper.

#### IV PRODUCTIVITY AND FIRM PERFORMANCE

In this section, the measurement of productivity is discussed, within the overall performance of the firm. The analysis begins by considering the problem in the context of a cross-sectional comparison of the productivity of a set of similar production units.<sup>5</sup> Subsequently, the focus is switched to a comparison of the productivity of a single production unit through time, a more relevant focus for planning purposes.

##### 4.1 - Work Done and Valued Added

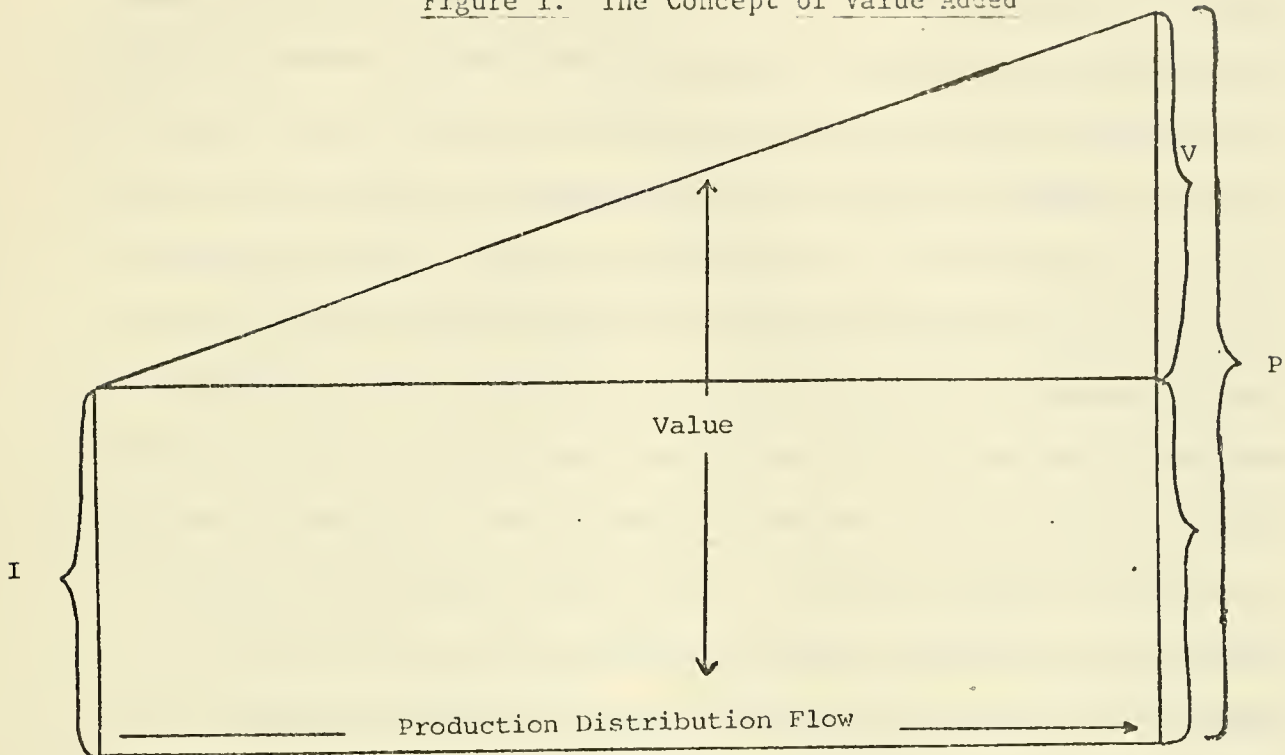
Productivity measurement attempts to assess resource usage in relation to the work accomplished by a production unit. Neither sales revenue, nor some physical measure of output, solely reflects a unit's work done, because included in the gross output vector is purchased input. That is to

say, the gross output vector includes both raw material content, and the work done by other organizations in supplying to the unit in question some of the inputs used to create its outputs. To illustrate, Ford Motor Company is considerably more vertically-integrated than is American Motors. Thus, American Motors will use less of its own labor and capital assets than Ford per vehicle produced. This does not mean that Ford is less productive than American Motors. Ford, within the work systems under its direct corporate control, is carrying out more of the work required to convert raw materials to finished product in the hands of the ultimate customer.

Thus, two firms competing for the same segment of product-market demand may exhibit very different cost functions simply because one of the firms does a higher proportion than the other of the total work of converting raw materials to final product. In such circumstances, it is clearly pointless to compare the total accounting costs of each firm as a ratio of their respective sales revenues. The firm doing the greater proportion of work should show a lower ratio of cost to sales, or conversely a higher operating margin. This argument is equally applicable in the case of analyzing the movements in a single firm's efficiency over time. The strategic choice of the degree of vertical integration has to be normalized in the measurement of productive efficiency.

In economic terms, work done is a component of value added. The concept of value added is illustrated in Figure 1. Its measurement, for a designated time period, is also noted. Because the concern is with the valuation of work done during the period, rather than with production sold, an inventory adjustment has to be included in the measurement.

Figure 1: The Concept of Value Added



$P$  = price per unit of output in final-demand market.

$I$  = market price of raw resources per unit of final output.

$V$  = value added by the production-distribution process.

$$V = P - I$$

For a firm, and a designated time period  $t$ :

$$(\text{Value Added})_t = (\text{Sales Revenue})_t - (\text{Cost of Purchased Goods and Services})_t$$

1 Changes in Inventory Position (valued at output prices).

Alternatively:

$$(\text{Value Added})_t = (\text{Economic Cost of Work Done})_t + (\text{Profit})_t$$

Where

$$\begin{aligned}
 (\text{Economic Cost of Work Done})_t = & (\text{Cost of Labor Usage})_t \\
 & + (\text{Cost of Capital-asset Usage})_t \\
 & + (\text{Cost of Financial Capital Invested})_t
 \end{aligned}$$

Under conditions of perfect competition, the profit component of value added would be zero, and all the other factors comprising the value-added vector would be uniquely and unequivocally determined by reference to prices in a firm's input and output markets. Further, under such conditions, there could be no advantage gained by a firm's management choosing to span a greater or lesser portion of the production process between raw resources and final output, because the returns to labor and capital inputs would be equal throughout the production chain. If, however, the possibility is admitted to of a condition of continuous disequilibrium - even if economic forces are simultaneously exerting pressure towards an equilibrium position - then all the familiar measurement problems, with which accountants have struggled over the years, reappear. Moreover, the role of strategic management in guiding the affairs of the firm resumes significance.

#### 4.2 - Cross-sectional Analysis of Productivity<sup>6</sup>

The comparative measurement of productivity among production units during a defined period of time requires normalization on two dimensions. First, in line with the immediately preceding argument, differences in degree of vertical integration have to be allowed for by relating input usage to net, rather than to gross, output. And secondly, to allow for differences in scale of production, resource usage has to be related to a single unit of net output.<sup>7</sup>

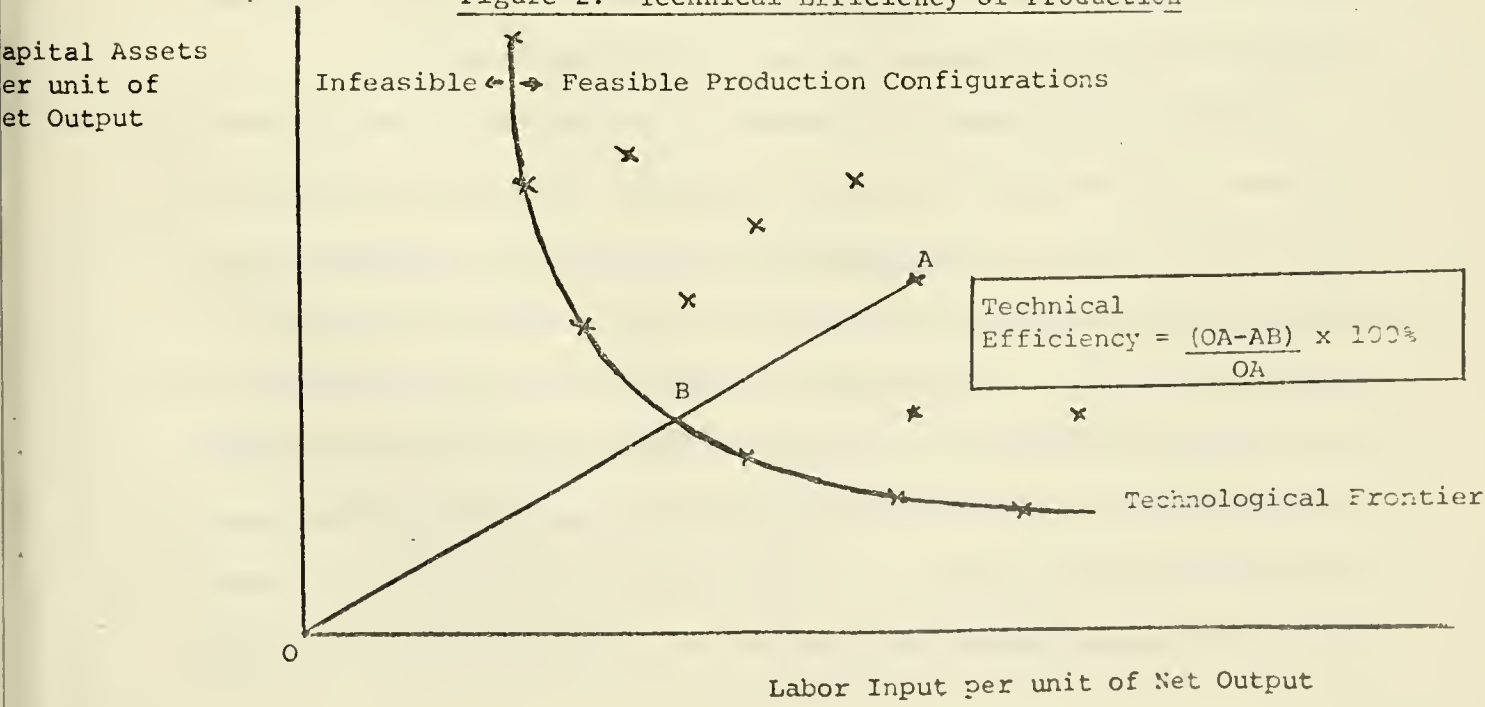
From among all the explanators potentially contributing to productivity, the argument of this paper focuses on the capital-asset/labor mix used in the production process (see Farrell [16], and Ball [5]). While other factors may from time to time assume great prominence (for example, the availability and cost of energy), the capital-asset/labor mix is an enduring key variable of economic management. It is key in three senses. First, it relates centrally and directly to jobs and income, and therefore to the



accomplishment of an organization's employment objectives. Secondly, it can be managed in a directed, purposeful way, in relative contrast to less tangible aspects of productivity and overall efficiency. And finally, much of a firm's cost function can ultimately be factored into a substitution equation defining the economic trade-off between using labor and using capital assets in the production process.

In Figure 2, it is assumed that the production units being compared can be located on a scatter diagram according to the capital-asset/labor input mix to produce one unit of net output. The diagram in Figure 2 depicts only the combination of two undifferentiated inputs - capital assets and labor - to produce one undifferentiated output. However, methods have been developed to allow a generalization of this to handle the combination of multiple inputs and multiple outputs (see Charnes, et al. [11]). At least in theory, therefore, provided the data is available, the input and output vectors of the set of units can be increasingly finely divided in order to recognize significant differences in the respective inputs and outputs.<sup>8</sup>

Figure 2: Technical Efficiency of Production



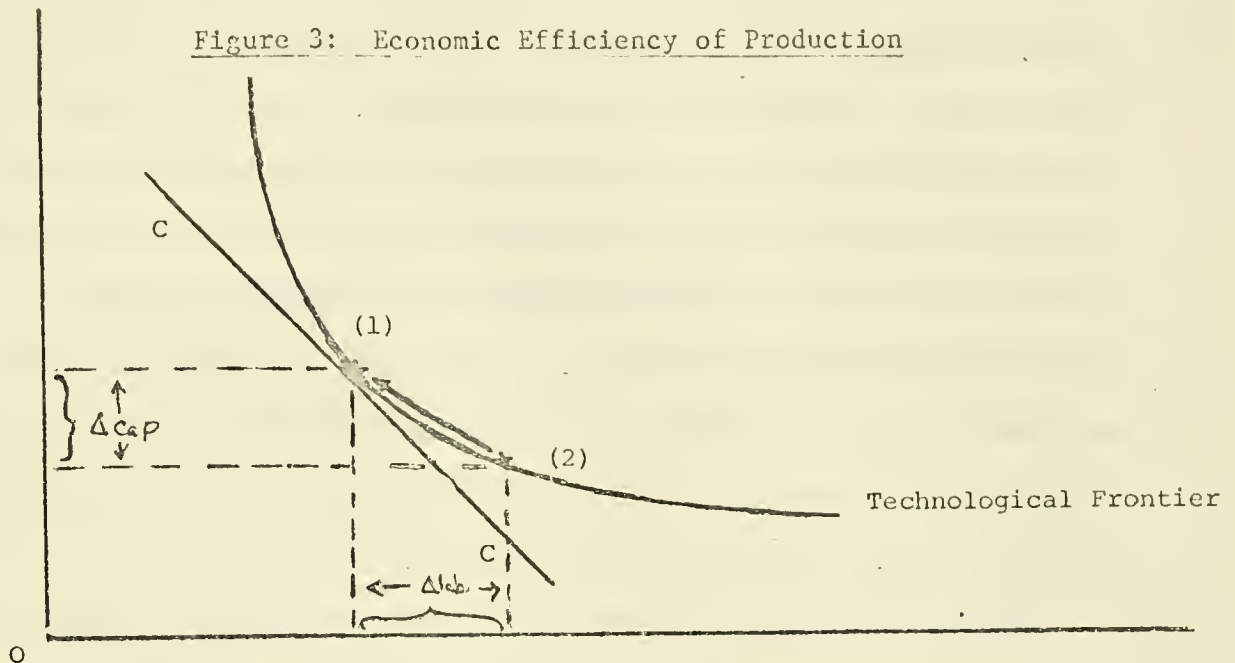
The Charnes method also provides an algorithm for constructing the extremal relations in the set of observed production units. That is to say, the envelope around the firms, a surface in multi-dimensional space (two dimensions in Figure 2), representing the most efficient production, can be constructed from the observed data points. In Figure 2, this envelope is labelled the "technological frontier." It is an empirical construct. It simply asserts that, based on the best efficiency observed, there is probably some technical barrier which constrains the efficiency of production. Thus production points within the frontier are feasible, while those outside the frontier are assumed currently to be infeasible.

This construct allows a definition of technical efficiency (Ball [5]). The technical efficiency of a firm is simply visualized as the distance of the firm from the technological frontier, relative to its distance from the origin. Thus, technical efficiency is calculated by  $(OA-AB)/OA$  multiplied by 100%. If a unit is operating on the frontier ( $A = B$ ,  $AB = 0$ ), it is fully efficient in a technical sense. A unit operating at some finite distance within the frontier could, using currently-known technology, find a production method which uses less labor, less capital assets, or some lesser combination of both, to produce the same unit of net output.<sup>9</sup>

In Figure 3, the argument is expanded to include the notion of economic efficiency. In the diagram, units (1) and (2) are indistinguishable in their technical efficiency; they are both on the frontier and are therefore 100% technically efficient. However, one of the units may be using a capital-asset/labor mix which results in a lower cost per unit of net output than the other. The line CC represents an industry-specific curve defining the rate of cost substitution between the use of capital assets and labor in the production process. It is of course an empirical question as to whether such a curve can be uniquely defined for an industry (or even for a single

Capital Assets  
per unit of  
Net Output

Figure 3: Economic Efficiency of Production



Labor per unit of Net Output

firm), and if so whether it takes a linear form. However, assuming that the line can be constructed, the point at which the line meets the technological frontier uniquely defines the point of optimal efficiency. In Figure 3, unit (1) is more efficient than unit (2) by reference to the economic cost criterion. Unit (2) could change its production method by substituting capital for labor, where the cost( capital) is less than the cost(labor).

Total production efficiency, then, conceptually combines two notions: the notion of technical efficiency, as explained in Figure 2; and the notion of economic efficiency, as explained in Figure 3.

#### 4.3 - Productivity as a Component of Performance

Before proceeding to a longitudinal analysis, the impact of productivity on the overall performance of a firm requires some comment. While more productivity is usually preferable to less, this is not to say that a firm's management should attempt to maximize productivity in an unconstrained manner. This would only be appropriate in conditions of perfect competition, in which case productivity would be indistinguishable from

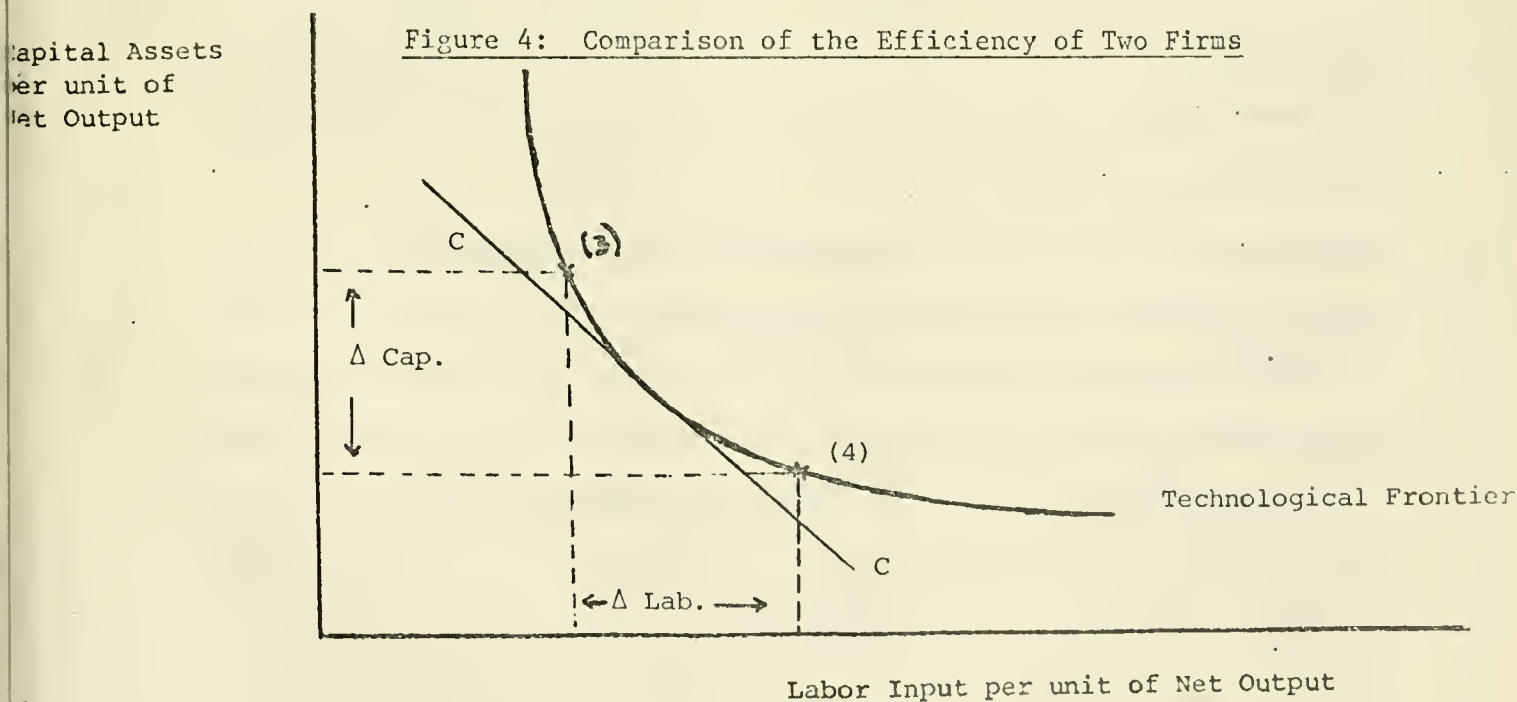
profitability. So long as a conceptual distinction is maintained between the internal efficiency, or productivity, of a firm and its external effectiveness, there exists the possibility that gains in one may be achieved at the expense of the other. This distinction is advanced by Anthony [4], and would seem for managerial purposes to be useful. But, as already pointed out, the implied departure from an assumption of a competitive equilibrium means that a strict factor analysis of a firm's performance into its efficiency and effectiveness components is not feasible. Any method which claims to measure these factors of performance must rely to some extent upon judgmental input.<sup>10</sup>

Efficiency measurement, under conditions of disequilibrium has to rely upon relative rankings - among industries, among firms within an industry, and between states of a single firm at different points in time. Moreover, for a single firm, efficiency may have to be viewed from the perspective of its management's objectives. Ball [5] points out that criticism of a particular firm's efficiency may not be a comment on how well that firm manages the relationship between its inputs and outputs, but rather a criticism of its objectives. Nonetheless, in a general sense, in order to continue to command from society the resources necessary to maintain its existence, a firm must have both objectives which are consistent with societal needs (the effectiveness criterion) and the control technology to acquire and use resources efficiently in attaining these objectives. This by no means implies that different firms, even firms with very similar product-market objectives, must of necessity accord the same priority to the various elements of efficiency in their competitive strategies. On the contrary, competitive disadvantages in one area of efficiency may be offset by advantages in other areas.

In the absence of perfect competition, no particular objective can be

claimed to have theoretical superiority over any other. But, if it is assumed that competitive forces are at least tending to move the economy towards an efficient equilibrium, then profit maximization acquires a fairly compelling status as a dominant managerial objective. The problem is to translate the notion of profit maximization into operational terms.

Returning to the previous conceptual framework, Figure 4 illustrates the comparison of two firms, each of which, within the limit of uncertainty of the measurement process, would probably be considered indistinguishable in terms of both technical and economic efficiency. Suppose they are also indistinguishable in all other aspects of their performance.<sup>11</sup> Both firms would clearly earn the same rate of economic profit per unit of output. And yet they would not have the same measured accounting income, because of the incomplete way in which the cost of financial capital invested in a firm is treated under generally accepted accounting methods.



The use of a "residual income" measure would, however, give a correct comparison of performance between the firms, provided the cost of financial capital and the pattern of recovery of financial investment were correctly estimated in the accounting system. This measure was first proposed by GE in the early 1950's for internal use in assessing the

financial performance of its various businesses. Despite its conceptual superiority over other commonly-used measures, such as net income divided by the book value of invested capital, it apparently has not gained widespread adoption in practice (Reece and Cool [29]). The reasons for this are not clear, but a salient one is probably that a residual-income measure departs from the normal accounting framework for reflecting financial performance.

If residual income is accepted as a reasonable accounting proxy for economic profit, maximization of residual income as a managerial objective can be claimed to be sound from a normative economic perspective.<sup>12</sup> Its maximization can be visualized as being achieved jointly through the choice of strategies and the efficiency of their implementation. An analytical schema is illustrated in Figure 5.

Figure 5: A Causal Analysis of Firm Performance

<u>CAUSAL FACTORS</u>		<u>DOMINANT OBJECTIVE</u>
[STRATEGY CHOICES-----IMPLEMENTATION]	⇒	PROFIT MAXIMIZATION

Decomposition of these:

<u>STRATEGIES</u>	<u>IMPLEMENTATION</u>	<u>RESULT</u>
PRODUCT-MARKET-----	ENTREPRENEURIAL	
- Scope and	EFFICIENCY	
Variety of Output		
PRODUCTION-----	PROCESS	
- Vertical Integration	EFFICIENCY	
- Capital-asset/Labor Mix		
SOURCING-----	INPUT	
- Physical Factor	EFFICIENCY	
Inputs		
FINANCING-----	FINANCIAL	
- Mix of Sources	EFFICIENCY	
of Finance		

⇒ RESIDUAL INCOME

Where:

PROCESS EFFICIENCY = PRODUCTIVITY

Output efficiency, or entrepreneurial efficiency, is achieved through the effective management of the firm's product-market interface. The term "entrepreneurial efficiency" is preferred because it is descriptive of the kinds of activities entailed in its management. Essentially entrepreneurial efficiency results from effective definition of market needs, development of products to meet these needs, establishment of the context of product exchange, use and utility between the firm and its customers, and communication with existing and potential customers to create and sustain demand for the product offering. Conceptually, the contribution of entrepreneurial efficiency to the firm's value-added vector is economic profit or, in accounting terms, residual income. It is the difference between the firm's value added and the market-derived cost of efficient work done to create, manufacture and distribute products.

Input efficiency is concerned with the management of the firm's interface with its supplier and labor markets. It is a function of the firm's ability to estimate its requirements, to source its environment for reliable, low-cost suppliers, and to acquire, develop and sustain its own sources of supply where cost and security of supply considerations might render this advantageous. Thus, the problem of maintaining an efficient supply of resources to the firm is not dissociated from the strategic choice of the degree of integration along the continuum from raw materials to final product. Where markets become unstable, and supply uncertainty great, a firm may attempt to use its economic power to absorb more of its sources of critical inputs, thereby rendering them subject to the firm's managerial control rather than to the market's control. It is, of course, an interesting theoretical and practical question whether a firm can reduce its aggregate risk by such a strategy or, more broadly, whether overall social welfare is enhanced as a result.

Process efficiency is akin to the commonly-accepted notion of productivity. Given the demand for output, and the strategic configuration of the firm's work systems, process efficiency is concerned with minimization of the consumption of resources to produce the designated output. The measurement of productivity is usually conducted in the context of these ceteris paribus assumptions, and in an ex post mode of analysis this may, for some purposes, be appropriate. But in a proactive, ex ante mode it is not, because it does not recognize the strategic inter-dependencies between productivity, the firm's strategic choices, and conditions in the firm's total environment.

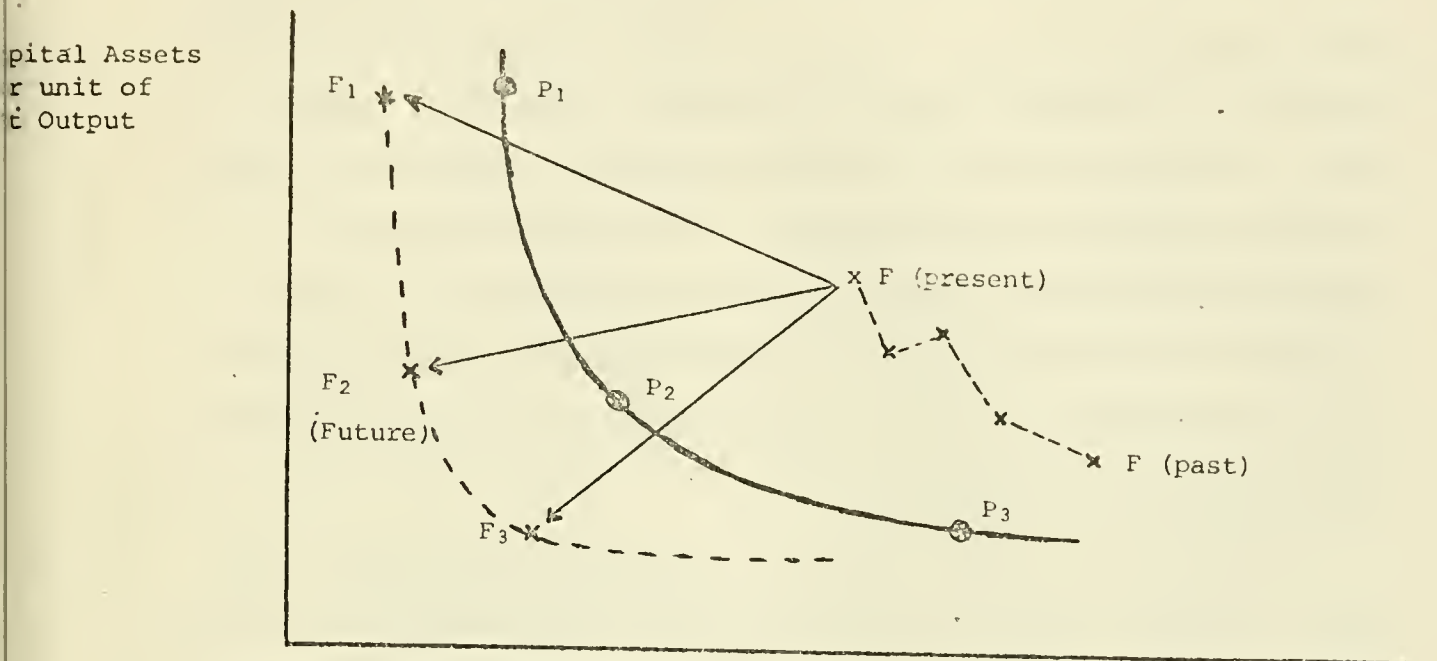
Financial efficiency is concerned with the interface between the firm's financial markets and its investment and operating activities. Given the cash and profit flows expected from the firm's business strategies, the financing strategy is concerned with finding a mix of sources to finance these at minimum expected cost, bearing in mind prevailing tax structures and costs of financial distress. At times, the conditions in a firm's financial markets may be such as to provide opportunities which drive the choice of investment and operating strategies, reversing this suggested flow of the managerial logic.

#### 4.4 Longitudinal Analysis of Productivity

In Figure 6, the focus of analysis is altered to consider the path of one firm through time. The purpose of this is to suggest a methodology useful to the management of firm F in approaching the task of charting its future direction with regard to managing for productivity.



Figure 6: Productivity Paths through Time



The proposed methodology includes the following steps: (1) analysis of where the firm has been in the past (F past); (2) understanding its current position (F present), relative to selected competitors (Pi's) which are reputed to be in the vanguard with regard to efficient production; (3) exploration of future positions (Fi's) in terms of technical feasibility and economic attractiveness; and (4), charting out a future direction.

Harvey and Morris [22] present an excellent analysis which makes a comparison of the relative movements in productivity of 21 firms in the UK machine tool industry between 1973 and 1977. Their approach is suggestive of the kind of analysis which a single firm might fruitfully conduct for itself. Indeed, a firm's own analysis would be considerably richer in analytical detail and explanation, because of a greater amount of data than Harvey and Morris had available to them. In the diagram of Figure 6, the firm has pursued a path of increasing labor productivity. However, this has

resulted in (or been caused by) an increased use of capital assets. Moreover, it is conceivable (indeed likely) that the labor mix has also changed during the years plotted on the diagram. Harvey and Morris point to two further factors which should be taken into account in the analysis. First, the relative amount of purchased component in gross output may have changed. This suggests that the points on the diagram should be supplemented by a note of the value added to gross output ratio. And secondly, they note that changes in performance could have been caused by changes in output price levels relative to input costs, rather than by changes in productivity directly.

In assessing its current position - F (Present) on the diagram - the firm's management may wish not only to analyse its own performance, but also to compare its performance with that of a relevant peer-group of companies (Pi's in the diagram). In practice, the technological frontier may not be known. However, by a judicious selection of the peer-group companies, some reasonable approximation of the frontier may be simulated. An alternative may be to use the PIMS data base to construct an external basis for comparison (see Gale [18]).<sup>13</sup>

Next, the diagram suggests that the firm's management should attempt to construct future feasible operating configurations (Fi's on the diagram). Clearly, this involves technological forecasting, and the choice of a planning horizon. The planning horizon should be sufficiently far in the future to allow a type of planning which is not simply an extrapolation of current rates of improvement in capital assets and production methods, but which nevertheless is grounded in some recognizable feasibility. In other words, a meaningful compromise should be struck between "following one's nose" and "science fiction."

The Fi's are spread around the future technological frontier, in order

to heighten, or dramatize, the potential differences in production configurations. This makes clearer the radically different strategic options which may be available.

Along with the future feasible options, a forecast has to be made of the cost-substitution curve between capital assets and labor. In this regard, general price-level changes are irrelevant. What is important, however, is the possibility of relative price changes between capital assets and labor. Currently-evolving technology appears to hold the promise of radically cheaper (in real terms) capital assets. Productivity gains from the use of these assets will presumably in part be shared with labor. However, if a time lag between productivity gains from the use of higher-quality capital assets and wage contracts were to persist, then capital assets would maintain through time a favorable cost differential, in real terms, over labor.

Finally, management has to decide on a preferred future state, and chart a course towards it.

A planning process, consistent with this conceptual framework, is presented in the next section.

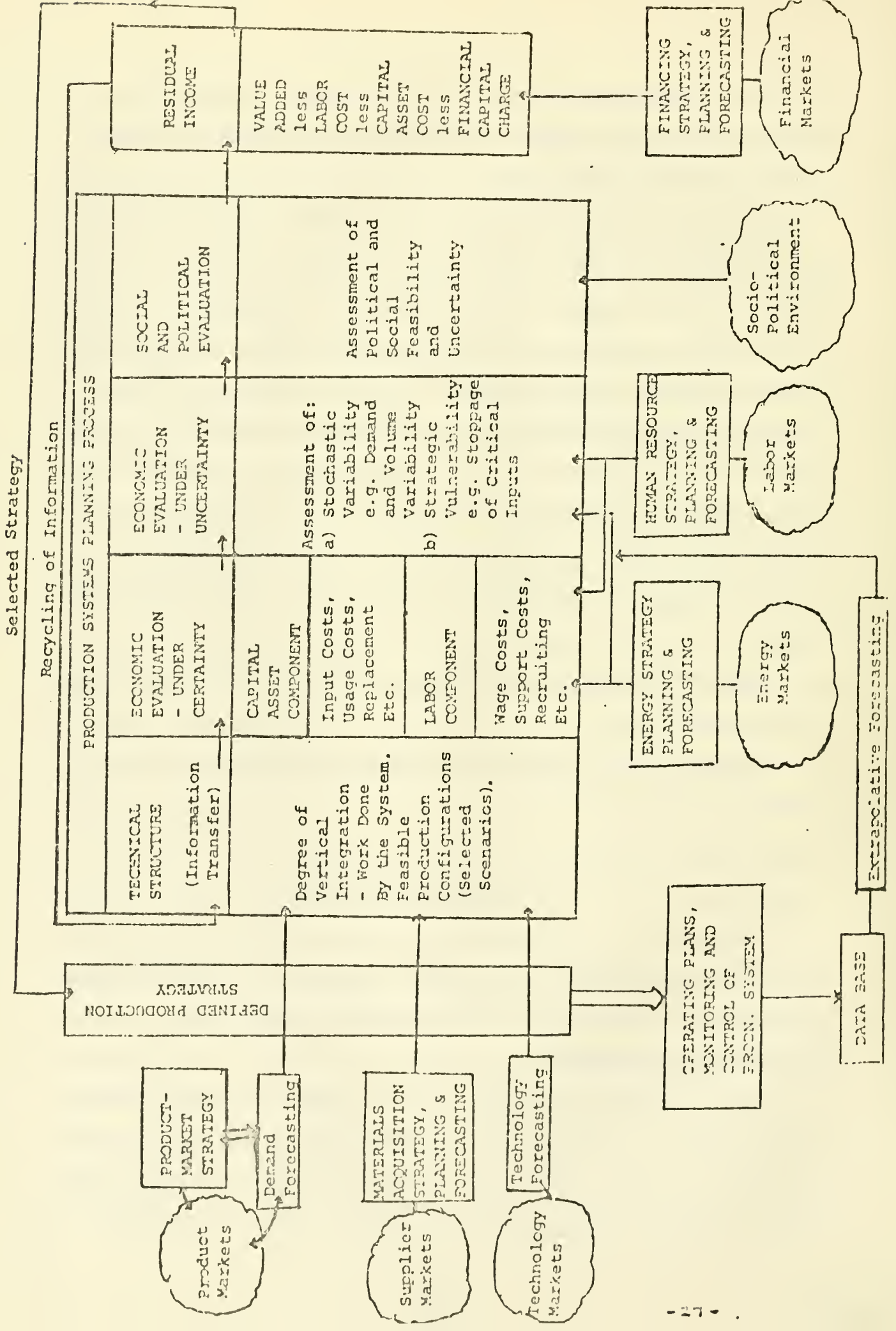
## V. A PLANNING FRAMEWORK

The proposed framework is illustrated in Figure 7. Before discussing the framework, however, some preliminary comments are necessary.

### 5.1 - Preliminary Comments

A normative financial theory of the firm suggests the need to find an optimal solution to the production, investment and financing opportunities available to the firm, jointly and simultaneously across all relevant time periods in the firm's planning horizon. Such a prescription would require a

Figure 7: Proposed Planning Framework



total system modelling, unambiguous goal specification, resolution, prior to decision making, of all relevant uncertainty in the firm's future, and an algorithm by which to derive from forecasts an optimal set of plans. The proposed framework does not intentionally depart from the spirit of these normative precepts. However, in the interests of tractability, it is considerably less ambitious in its formal prescriptions.

Two simplifying devices are used. First, in the spirit of functional separatism, it is assumed that the firm's overall strategy can, as a first approximation, be decomposed into its functional elements. Thus, the framework depicts an analysis of the firm's environment into specific parts, each one of which is the subject of an articulated sub-strategy. These sub-strategies are shown as being set independently of one another, each one feeding information to the analysis leading to the choice of a production strategy. However, it is visualized that the implementation of the framework would entail several iterative cycles, in the course of which successive heuristic approximations would move the analysis closer to dealing with the various uncertainties within each sub-strategy, and with the real interdependencies among the elements of the firm's environment. To illustrate, the socio-political environment is clearly pervasive in its impact, affecting, and being affected by, conditions in the markets for labor, financial capital, energy, technology, material and service inputs, and product outputs. The final stage of the planning framework, a socio-political assessment of considered strategies, is intended to include an integration of the various pieces of the analysis from this particular perspective.

Secondly, the problem is partitioned into its strategic, tactical and operational elements. Only the strategic element is considered in detail. Of particular importance in this regard, the model embedded in the framework is essentially static and, besides being long-term future orientated, is otherwise time-independent. In practice, many models which purportedly support strategic planning are intertemporal models operating within a clearly-defined planning horizon. Inevitably, such models must combine two sets of issues - strategic (what future state from among a set of possible states is preferred), and tactical (what path should the firm follow to move from its present position towards the preferred future state). Admittedly, it is ultimately a matter of semantics whether both sets of issues should be included within the rubric of strategic planning. They are, to be sure, considerably interdependent. However, the distinction is not a trivial one. If it is not maintained, the danger exists that the creativity necessary to visualize and define future scenarios which are radically different from the existing order may be severely curtailed by a tendency to resort simply to an extrapolative form of planning.

The framework does however include extrapolative forecasting as part of the input to the strategic scenario generation. Current trends, extended into the future by, say, an econometric forecasting method, can clearly provide useful information, in at least two ways. First, they provide a base-point scenario, a point of departure from which to analyse proposed strategic changes. And secondly, they are of significance in the derivation of cost and price parameters as input to the economic analysis of tested scenarios.

## 5.2 - Unit of Analysis

For managerial purposes, the capital-asset/labor mix is unlikely, in any but the simplest of firms, to be amenable to treatment at the level of the

total firm. This is because the different activities comprising the firm - primary production, distribution, marketing and sales, administration, etc. - are likely each to face different opportunities for the deployment of capital assets, and different cost-substitution curves.<sup>14</sup> Thus, in mapping the planning framework into an organization, it will be necessary to analyse the firm's various activities into sub-sets by reference to their characteristics on these dimensions, and to define the sub-sets as primary planning units for this particular purpose. Such an analysis may coincide with the existing responsibility structure in the organization, but it is possible that it will not. The planning system will in turn require a definition of procedures for combining and coordinating plans developed at the primary level of analysis.

### 5.3 - Stages and Sequencing of the Planning Process

The first stage of the proposed planning process deals with the definition of future feasible production configurations (the  $F_i$ 's from Figure 6). The product-market strategy provides a preliminary forecast of such things as the product-diversity, volume of output, and geographic distribution of sales. The supply strategies are intimately bound up with deciding on the degree of vertical integration of the system. The two together provide a forecast of the work to be done by the production system. The scope and magnitude of the work to be done may be an important factor in determining the opportunities for different capital-asset/labor configurations. Therefore, the technical structure possibilities have to be jointly considered with product-market and supply strategies, rather than being considered to be determined by a prior specification of these.

The next stage proposed is the economic evaluation of selected configurations, under conditions of assumed certainty, followed by an evaluation under conditions of uncertainty. Two kinds of uncertainty are

identified. First, consideration is proposed of the economic effects of stochastic variability in such things as demand, price and volume. Normal sensitivity methods are quite adequate to handle this part of the analysis. But in addition, a strategic simulation approach is also suggested, to test the robustness of considered configurations to major strategic disruptions, such as labor stoppages or discontinuity in energy supplies.

The final stage of the proposed analysis is an assessment of the socio-political aspects of the considered production strategies. The logic of leaving this to last may not be clear. In a sense, it stems from a philosophy of dealing, in a planning context, with those phenomena and events about which most knowledge and understanding is available, and over which most control can be exercised, then proceeding sequentially to extend the analysis into lesser-understood domains. But further, it stems from an aim of not excluding from consideration possible production strategies on the grounds of a premature conclusion that political difficulties might render them infeasible. Undoubtedly, political strategies will be necessary to effect a satisfactory accommodation with the radical changes which the longer-term environment will inevitably bring.<sup>15</sup> It is as well to estimate as fully as possible the potential gains of possible proactive changes before assuming them to be infeasible. They may not be, especially if potential gains are incorporated into a well thought-out negotiating strategy.

#### 5.4 - Financial Objective

The framework suggests that, within the defined constraints of the selected strategies, the production strategy which leads to the largest expected residual income is, all else being equal, the strategy to be preferred. There may however be good reasons for selecting a strategy with a lower residual income. For instance, a preferred strategy might offer



superior prospects in the realm of social goals - for example, it might offer the likelihood of less discontinuity in levels of employment. Superior performance on this dimension might ultimately translate into greater profit potential for the firm, even though the precise calculus for computing the potential may be considered problematic. Then again, a lower expected residual income strategy might be judged to be more robust than the "maximal" strategy against some of the strategic contingencies. This too, in theory, could be entered into the calculation of expected residual income, but it may be very difficult to do so. In essence, it seems appropriate to suggest that management should exercise a judgemental prerogative in this area of strategic choice. It simply may not be efficient to attempt to reduce all areas of managerial judgement to the precise calculus of a formal economic relationship.

There remains the question of dealing with a time preference for realized residual income; different strategies are likely to have very different temporal patterns of residual income. This is, of course, a familiar problem in the area of financial planning. The most direct way of dealing with it is to accumulate annual residual incomes for each considered strategy, and apply to them a market-derived opportunity cost of equity capital. The sum of the discounted residual incomes, plus a terminal annuity, would then provide the basis for rank-ordering considered strategies.

## VI FINANCIAL SIMULATION

A central problem in implementing complex planning is the development of an information processing support for the managerial organization. One facet of this concerns the ability to translate readily from the language and conceptual constructs of strategy to the language and analytical framework of accounting. Another facet concerns the ability to trace the

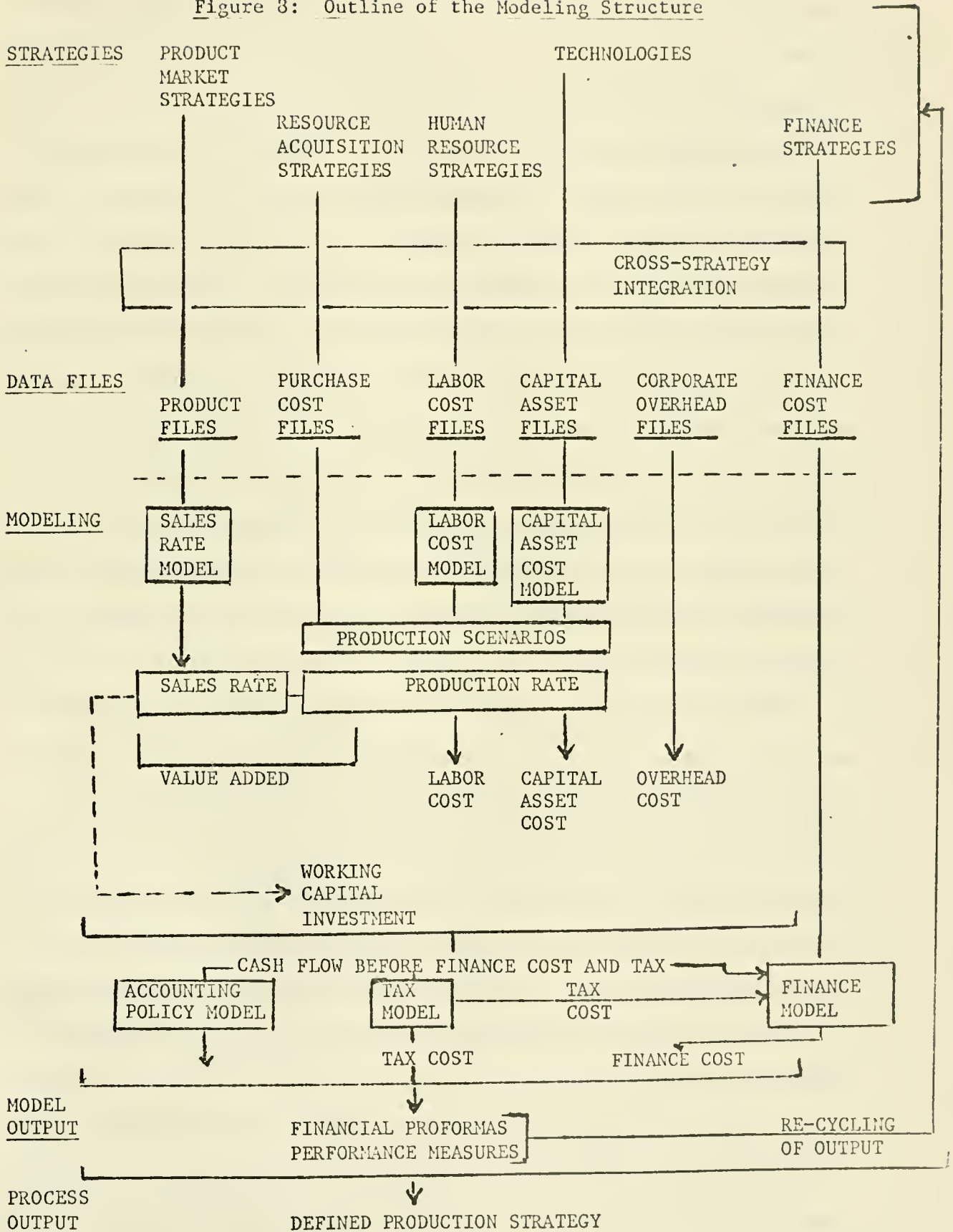
combined effects of multiple and perhaps simultaneous strategy modifications to the consolidated financial performance of the enterprise. As part of a strategic planning process, managers generally wish to test considered strategies in terms of their expected impact on the financial statements of the firm, and on the performance measures selected to indicate the degree of the firm's goal attainment. This is especially true when radical, as opposed to incremental, changes are being considered. And in these circumstances it is especially difficult to do because an intuitive connection between strategies and financial outcomes, based on experience, is less likely to be reliable. A more formal method recommends itself. In this section the features of a financial modeling system, tailored specifically to supporting production strategy decisions, are discussed.

Figure 8 illustrates the general structure of the suggested system, and its connection to the planning process. The model is simply a calculating device, based on the procedural syntax by which transactional inputs are converted to financial statement outputs.<sup>16</sup> The strategic assumptions and choices, defining in aggregate terms the future volume and mix of transactions, are visualized as being supplied to the model by the managerial organization; they are not, in other words, subsumed into, or generated by the model itself. The aim is to create a supportive and responsive modeling system, one which can be comfortably integrated into the planning process without its exercising an undue normative force on the process. The modeling system also provides a focus for, and a repository of, organizational learning about the environment of the firm and the behavior of its cost functions.

#### 6.1 - Data Files

Central to the modeling system is a set of data files, containing an up-to-date description and economic estimation of the firm's actual and

Figure 3: Outline of the Modeling Structure



potential products, purchased inputs, labor categories, capital assets, corporate overheads and financing sources. The content of these data files is jointly determined by forecasts of the conditions in the firm's factor and output markets, and by the choice of sub-strategies. For example, the labor cost files contain the expected costs of labor, by relevant category. These costs might be determined simply by reference to a forecast of prices of each labor category in the external labor market. However, the human resource strategy of the firm might choose to emphasise a "make" rather than "buy" preference. That is to say, the policy may be to invest in education and human development within the organization to generate requisite human skills. While the costs of particular labor categories, pursuing such a strategy, may not be entirely independent of expected external prices - since the firm is still likely to wish to maintain some defined relationship between its own labor rates and external rates - they nevertheless are likely to be different.<sup>17</sup>

The data files, then, appear innocent enough within the modeling structure portrayed in Figure 8. But in fact they are crucial to the quality of the modeling, and they represent a very considerable amount of research and analytical effort to maintain in good order. If the managerial work in each area is visualized as being divided between the operational implementation of current strategies, and the research, analysis, and judgement which goes into supporting the definition of future strategies, the data files can be thought of as providing a focus for the latter component of managerial work.

## 6.2 - Production and Cost Functions

Intervening between the data files and the modeling of production and cost functions are several sub-models. In particular, in the context of the current discussion, a labor cost model and a capital-asset cost model are

proposed, with the purpose of efficiently providing input to the more integrative modeling of production and cost functions. It has already been argued in the course of the discussion that the production strategy choice should focus on the capital-asset/labor mix. Thus, the cost sub-models should be designed to provide information which allows a cost comparison to be made between strategies characterised by different mixes and rates of investment in labor and capital assets respectively. A discussion of the forms of these sub-models is deferred for a moment, in order to consider first the general thrust of the overall financial simulation.

Those costs which are believed to be independent of the capital-asset/labor mix choice, could, for the decision purpose at hand, be excluded from the model. It is assumed, however, that for the sake of completeness a total-enterprise model is likely to be preferred. Therefore, other cost modules are included. For example, a corporate overhead module, which may be viewed as containing organizational costs which will be incurred regardless of the specific strategic choices of the firm, is included. And a finance cost module is also included.

The finance cost will be dependent on the production strategy choice - through the profile and stability of the expected cash flows resulting from this choice. One tradition of finance theory would limit the dependency to this. Another tradition however would suggest that the sources and costs of finance to a firm are more directly dependent on the characteristics of the investments the firm is making. Differential tax treatment of types of investment, and the conditions of lending covenants would, at least on the surface, support the plausibility of the latter proposition. For example, equipment leases may be an efficient mode of financing the acquisition of certain kinds of capital assets, but inapplicable to the financing of investment in human resources. This latter view can be accommodated readily

in the modeling system by entering into the finance sub-model constraints and conditions reflective of the assumed connection between the characteristics of an investment strategy and its financing.

A perplexing issue in the modeling concerns the treatment of the relationship between the revenue and the cost functions. Economic theory suggests they are interdependent, each being determined by the other through the equilibrium conditions of marginal cost equalling marginal revenue, these in turn being determined by the market prices of inputs and outputs. But a strategic analysis is seeking a competitive advantage which would allow the firm's management the discretion, at least in part, to uncouple the two. In point of fact, lacking a means of modeling the future competitive environment, including the specification of demand conditions, competitor strategies, and the response of both of these to the firm's own strategies, it is impossible strictly to specify in advance the connection between revenues and costs. Thus, the most that can be done in the modeling system is to provide a means by which to explore a number of assumptions about the relationship, relying ultimately on the managerial organization to exercise its judgement as to the conditions they feel are likely to prevail. One approach would be to make revenue a function of cost by specifying a markup, which could be constant throughout the simulated time periods of a model run, or could be varied through time at the command of the user. This could provide interesting information to management. But, if costs were to behave in an erratic manner, reflecting for example a transition between one production strategy and another, the resulting revenue function would seriously lack realism. At the other extreme, the revenue function could be specified totally independently of the production strategy. In this case, the modeling would presumably resort simply to a search for the production strategy promising the least cost. Between these

two extremes, provision should be made to allow a modeling of a rich and varied set of interdependencies between output prices and costs, and between demand and supply conditions. For instance, a capital-intensive production strategy, compared with a labor-intensive strategy, may promise lower unit manufacturing costs but less responsiveness to stochastic variability in demand because of the need to sustain long production runs to optimize manufacturing costs. This might give rise to the need to carry higher levels of inventory, resulting in higher costs; or it might suggest a different pricing strategy to compensate for reduced levels of customer service, thereby affecting revenues. The modeling system should allow the flexibility to the user to input these kinds of distinctions between production strategies and their assumed effects on costs, revenues and the relationship between the two. While not trivial, it is nevertheless not a major technical problem to provide this degree of flexibility, given the progress which has occurred in recent years in user-orientated software.

### 6.3 - Reduction of Complexity

The modeling should aim to allow a close cognitive control by the users over the model. In other words, the processing logics of the model should be reasonably transparent to users so that they can at least intuitively comprehend the output from the modeling system as a function of the inputs and the modeling syntax. The use of a procedural language has already been recommended, because of the greater clarity of model syntax which this gives. In addition, the real complexity of the decisions under consideration must be significantly reduced. Certainly the complexity should be vastly less than that which is contained in the typical general-ledger type of financial model. An appropriate design philosophy would aim to reduce the categories of product, labor, capital assets, and financing sources to the minimum feasible, while still preserving the power

to discriminate differences in financial behavior arising from different production-strategy choices. Constraining the degree of factor reduction, however, would be the semantic preferences of the managers who are the ultimate users of the information coming from the modeling system. The output of the model must be both plausible to managers, and connect clearly to the qualitative distinctions and categories they use in their strategic deliberation. There would be little point, for example, in the modelers maintaining it is unnecessary to distinguish between employing fitters and research scientists on the grounds that they each have the same effect, within specified levels of significance, on the firm's cost function. Regardless of whether or not such a contention were true, it would be unlikely to be acceptable to managers, and could deservedly bring the modeling effort into some disrepute.

The connection between strategies and financial performance in the proposed modeling structure is established through the cash flows arising from strategic decisions. This in itself provides some transparency to the logic of the model, since managers by and large are well able to appreciate the connection between their decisions and resulting cash flows. An educational effort may be necessary to ensure that the full gamut of cash flow consequences of decisions are understood, but there is no conceptual obstacle to establishing a cognitive connection between decisions and cash flows. Such may not be the case in connecting between decisions and the way their consequences are reflected by the seemingly arcane methods of accounting and economic analysis.

In addition to cognitive clarity, modeling the cash flows allows a direct measurement of the intertemporal patterns of financial investment and recovery of investment. Thus, the time-phased pattern of financial capital invested in any tested strategy can be measured, without relying on the use



of an accounting proxy for this, such as the net book value of assets. Moreover, economic parameters, such as the net present value or the internal rate of return, can be computed directly from the cash flow patterns, providing additional information to the decision makers.

An accounting policy module and a tax module allow the cash flows to be converted into corporate financial statements. As part of the strategic decision process, it may be considered desirable to test the choice of accounting policies themselves on the presentation of the firm's results to outside parties. The form of the proposed modeling system readily permits this.

#### 6.4 - Steady-State Analysis

The analysis of strategy alternatives envisualized in the decision process would use as a first screening a comparison between the steady-state conditions eventually attained by pursuing each strategy. Starting from zero in simulated time, the financial characteristics of each strategy would be built up in successive simulated time periods until the financial performance parameters stabilize. At this point, the sales rate would be constant and equal to the production rate, labor and capital-asset costs would be the same in successive time periods, and working capital levels would be constant.

A static, steady-state comparison is a powerful tool in strategic analysis. On the one hand, it is consistent in philosophy with the notion of economic equilibrium. And on the other hand, it allows a careful examination of the structural properties of strategic alternatives. But to achieve a steady state may require some "force-fitting" of the underlying models of labor and capital-asset costs.

The labor cost sub-model, for each category of labor, would be most conveniently based on a physical growth model. The number of employees in a

category in a period would simply be an additive function of the beginning number, plus additions, less losses. The associated cost function might comprise a component which is independent of the numbers in a category, to denote a fixed-cost element, or a component which is a step-function with successive steps being triggered by defined threshold numbers to reflect semi-variable costs. More centrally, however, the main component would be determined by the number (and possibly mix) of people in each category. To relate numbers of persons to their capacity to conduct work (i.e., their productivity), a learning-curve equation could be used. This component of the labor cost sub-model might result in the overall model taking a very long time to reach a steady state; indeed, the model might never strictly converge. To reduce the amount of data processing in the model, the learning effects might be truncated after a small number of years for individuals joining a labor category. For example, an individual might be assumed to have zero productivity first year, 90% productivity second year, and 100% in the third and subsequent years. The precise form of the productivity equation would of course be a matter for research to ensure a reasonable proxy to empirical reality. Similarly, the capital-asset cost model would be based on a physical growth model, representing the acquisition, maintenance and replacement of assets. If continual gains through time are assumed in the technical performance and price parameters of assets, again the overall model might take a very long time to reach a steady state. A reasonable simplifying assumption may be necessary to render the model more tractable from a computational perspective. Reasonable, in this context, has to be defined in terms of the sensitivity of strategic decisions to the degree of simplification of the relationships in the model.

A challenging issue arises in the modeling of capital-asset cost,

concerning the degree of divisibility of assets. The preceding proposal implicitly assumes a large degree of divisibility of the total asset base, in conjunction with a perpetual useful life of the aggregate productive capacity of the firm.<sup>18</sup> Pragmatically, these assumptions may serve well for the majority of firms. And yet they may be in some conflict with the project focus adopted for the analysis of capital investment plans in many companies. The proposed method and framework simply provide a way of viewing capital investment in terms of the underlying rate of investment - a more appropriate perspective for strategic purposes. Even so, steady-state conditions will be more difficult to construct in the context of several large, indivisible capital-asset projects. The key to resolving the problem is in the way time is treated in the simulation. For capital-intensive firms, such as power utilities, a year may simply be too short a division of time to observe and understand the steady-state properties of the system. Five, or ten-year divisions of time, within a very long planning horizon, may be more appropriate. This points to the need to provide in the modeling system the flexibility to deal with radically different time units, in order to connect the strategic framework with other cognitive structures used in the firm's managerial process.

#### 6.5 - The Base Case

An early task in implementing the proposed modeling is the construction of a steady-state simulation of the firm's current production strategy. The purpose of doing this is two-fold: first, it provides a form of validation of the modeling; and secondly, it creates a base case against which to assess proposed strategy changes, and from which to trace paths from the current steady-state to new steady-states associated with alternative strategies.

To create a simulation of the current production strategy, the existing

labor mix and capital-asset mix need to be estimated, and current cost parameters developed for them. This then is translated into an annual investment module, reflecting the rate of investment to achieve and sustain the productive capacity. Starting in simulated time zero, an investment module is added. In each subsequent time period a further module is added, and combined with the cash-flow extensions of the investments in all the preceding time periods. Eventually this should result in a steady-state condition at a capacity level reflective of the firm's current capacity. By adding the revenue, purchased input component, corporate overheads, and financing, a simulation of the firm's performance under its current strategy, and at current costs, is created, independently of the actual general ledger data in the firm's accounts. The simulation model then has to be validated by a careful and detailed reconciliation between the simulated performance and the current performance as measured by the firm's accounting system. This will not be a strict validation, of course; it may be all but intractable to reconcile faithfully between the current-cost performance of a complex firm, and the history by which it arrived at its current state. Nevertheless, a reasonable and persuasive explanation of the differences between the two serves both to refine the modeling approach and to build managerial confidence in it.

#### 6.6 - Path Analysis

The second main analytical method envisaged in the approach is path analysis. This is important for a number of reasons. It allows managers to trace the performance path of an adopted strategy from zero to its steady-state, providing information especially useful when a new quantum of capacity is being considered. Secondly, it allows the tracing of paths from one strategic configuration to another. Thirdly, it allows an examination of the robustness of a strategy when subjected to strategic shock. For

example, once a strategy has achieved a simulated steady-state, it can be subjected to a variety of strategic contingencies - such as the stoppage of labor for defined periods of time. This permits an examination of its behavior in response to each contingency, and subsequently in regaining its steady-state when the contingent conditions are removed. Finally, and in a similar mode to the preceding point, the flexibility of the strategy to future modifications can be explored. An increase in the rate of investment can be simulated by adding a growth factor to the financial modules representing the basic strategy. Or a sudden burst of inflation can be simulated by factoring up the financial inputs and outputs from a point in time to reflect a new general price level. This should not of course affect the underlying economics of strategies. However, between strategies it may have a considerable differential effect on performance as reflected in the financial statements; for example, for some time following a pulse of general inflation, a capital-intensive strategy would presumably display higher levels of reported net income than a labor-intensive strategy.

## VII COST ANALYSIS

The discussion now turns to the development of the cost parameters entering into the data files. The cost of financial capital is discussed first, followed in turn by labor costs and capital-asset costs. Finally, inter-strategy costs are considered.

### 7.1 - Cost of Financial Capital

Financial capital is a requirement common to all production strategies, to both capital-asset and labor inputs. Regardless of the accounting treatment of expenditures, it is essential to estimate the magnitude of financial capital tied up in operations, and to cost this appropriately. The simulation method suggested in the previous section avoids the problem of estimating the pattern of capital recovery from operations, since the

cash flows to and from operations, and therefore the financial capital invested in operations for each time period, can be measured directly. Thus, the problem reduces to one of defining an appropriate cost of capital.

This is a very complex issue, about which much has been written. And yet the matter is far from having been resolved. For the present purpose, two assumptions are made. First, that the firm is able, and willing, to resort to the financial markets for its capital needs, so that the appropriate cost of capital is market-derived rather than an internally-derived opportunity cost; moreover, it is assumed that the financial market is both a potential supplier of capital and a source of information pertinent to the pricing of capital. And secondly, that it is feasible to distinguish between the market cost of capital for use by the firm in investing in productive capacity from the market cost of capital for use in working capital investment. This latter assumption is somewhat different from the more usual one that the market can give an appropriate price of capital for a specific investment project. Nevertheless, it seems justifiable because of the greater liquidity of most items in working capital compared with the investment in productive capacity. In practice, it is not at all uncommon for firms to arrange specific financing for items of working capital.

In very simple terms, the cost of financial capital can be thought of as comprising three components: the long-term, risk-free cost of money; a factor to compensate for the risk of the investments for which the capital is to be used; and a factor to compensate for expected inflation during the period between investment and repayment. A fourth component may arise in the market, simply reflecting temporary imbalances between the supply and demand for financial funds. For the purposes of the current analysis, only the first two components should be included in the cost of financial

capital, since general price level inflation is irrelevant, and long-term equilibrium positions are at the heart of the proposed analytical method. It hardly needs saying, but there exists no unassailable theory for deducing the cost of capital from empirical observations. Essentially this is a policy variable set by management. It contains within it a judgement about the preferences of the firm's stockholders between current and future consumption. In setting the cost of capital, the modeling system could be used to explore the sensitivity of strategic decisions to variations in the parameter, in order that management can make the determination in as fully informed a manner as possible.

## 7.2 - Labor Costs

The analysis of labor costs is illustrated in Figure 8.

Labor costs should include the total cost to acquire, train, use, support and, ultimately, to terminate, whether voluntarily or otherwise, employees. The types of cost shown in Figure 9 are intended to be illustrative rather than exhaustive. These costs have to be organized into the principal categories of employment, with categories being defined in terms of the distinctions commonly made in the course of management's strategic deliberations.

The point of the analysis is simply to stress the need to make a comprehensive estimate of labor costs. This should include the cost of providing the work space for employees, both the capital-asset costs of buildings and the ongoing costs of heating, insuring and providing physical security for them. Clearly, a considerable research effort is likely to be required to develop a meaningful set of labor costs.

Figure 8: Labor Costs .

COST INCIDENCE

CURRENT COSTS

DEFERRED COSTS

Acquisition

Recruiting (external)  
Recruiting (internal)  
Initial training  
Etc.  
Less - grants and credits

Usage

Salaries and Wages  
Overtime Premium  
Current Incentives  
Payroll Taxes  
Current Benefits  
Stock Options  
Etc.

Deferred Incentives  
Future Benefits

Support and  
Maintenance

Administration  
Supervision  
Space Costs  
On-going Training  
Etc.

Disposal

Termination Costs

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One problem concerns the measurement of deferred costs. These could be folded into current costs by projecting their future incidence, and discounting them at an appropriate rate to derive a present value. Alternatively, an estimated cost, reflecting that which would be incurred if the provision of the deferred benefits were contracted out to an independent third party, could be used. The choice of expression of labor costs will depend primarily on the convenience with which they can supply input to the modeling of the firm's aggregate cost function.

### 7.3 - Capital-asset Costs

Capital-asset costs, in a manner similar to the analysis of labor costs, are illustrated in Figure 9.

Figure 9: Capital-asset Costs

<u>INCIDENCE</u>	<u>CURRENT COST</u>	<u>DEFERRED COST</u>
Acquisition	Purchase or Design and construction Installation Less-grants and credits	Replacement
Usage	Power Supplies Routine maintenance Insurance Etc.	Major maintenance
Support	Administration Space	
Disposal		Removal Less - residual revenue

The analysis of capital-asset costs is not especially problematic from a conceptual standpoint, with the exception of the physical using up of the assets themselves. This is one of the most vexing issues in the realm of accounting measurement. Bearing in mind that the planning process which has been expounded to this point has separated out two of the confounding problems in ex-post accounting measurement - namely, the measurement of

financial capital cost and the stability of general price levels - the problem reduces to one of estimating the financial outlay to maintain the designated productive capacity. If this can be dealt with, capacity expansion can simply be treated as an additive extension of the method. Distinguishing between maintenance and expansion of capacity, in the face of technical advance, may pose a difficult estimation problem, but in the context of simulating future strategies it is not likely to be insurmountable; reasonably reliable engineering estimates can probably be constructed to levels of accuracy quite acceptable for the purpose.

Estimating the cost of the consumption of assets requires first the determination of a causal basis for predicting the useful lives of each asset category. For some, a volume of physical service may be appropriate, in which case the useful live will simply be a function of production rate. For others, technical advance, with associated economic obsolescence, will be a better basis. Next, a financial cost has to be attributed to the estimated usage of assets. The depreciation provision which will be made in the accounts may have no relevance to this, other than through the calculation of the incidence of tax costs. The relevant number derives from the financial outlays to maintain the capacity in prime condition, and comprises the sum of maintenance and replacement outlays.

#### 7.4 - Inter-strategy Costs

A final category to be estimated is the set of costs which vary between strategies, but which are not included in the financial capital, labor and capital-asset cost functions directly. To illustrate, some part of the purchased component of the input vector will be a function of the choice of production strategy. This will arise because of variations in the degree of vertical integration associated with different strategies. Further, variables such as material-usage efficiency (material productivity) may be

expected to be different between strategies. In a highly automated process, production tolerances and the necessary re-setting of machinery to achieve these can be centrally controlled. In a labor-intensive process there may be lesser reliability with regard to the observance of optimal rules governing the re-setting of machinery, with a resulting increase in the expectation of out-of-tolerance production.

### VIII IMPLEMENTATION AND MONITORING

In this section the implications of the preceding analysis for the accounting systems of a firm are considered briefly. These are addressed firstly from the perspective of supplying data to the planning process at the corporate level, and to the monitoring and analysis of movements in productivity at the level of the total enterprise. Then secondly they are addressed from the perspective of the operational planning, budgeting and performance measurement which is inevitably, in any large, complex firm, conducted in at least a partially delegated mode.

#### 8.1 - Data Generation for Corporate-level Requirements

It will be readily apparent that the data requirements of the planning framework will not be directly obtainable from existing accounting systems. Most accounting systems are structured to provide information about legally-defined entities. With the emerging concern for managerial information, general ledger structures have been embellished in an attempt to provide information for measuring the performance of the organization, viewed as a set of responsibility centers, and for measuring the performance of the enterprise, typically viewed as a set of partially-independent businesses, frequently defined from a product-line perspective.

The planning structure requires an analysis of the incidence and behavior of costs as a function of the rate and mix of investment in labor and capital-assets respectively, and of the mix among relevant categories of

each of these. To achieve this is likely to require the sustained effort of a team of analysts, bringing to bear on the problem a combined expertise in accounting, operations research, and managerial economics.

With regard to monitoring productivity, Craig and Harris [12] propose a method which is totally encompassing, even to the extent of associating tax costs with the input to the firm of services provided by Federal and local government bodies. Their proposal is interesting. It departs fundamentally from the framework suggested in this paper, especially with regard to the measurement of capital input. But its most important deficiency is that it gives no consideration to understanding the causality underlying observed movements in productivity. Thus, it is not geared to managerial needs. Harvey and Morris [22] indicate an approach which is considerably more analytical and therefore more aligned to the development of management information. Expanding on their approach, the analysis of changes in productivity should center on an understanding of changes in the value added of the firm, related to labor and capital-asset cost functions. In addition, price movements in purchased inputs and product outputs need to be monitored, so that output prices can be related to both the behavior of purchased input costs and the efficiency of the production process. Essentially, the total profitability of the firm is monitored, but from a more definitive standpoint than would be the case in the absence of the productivity focus.

Three bases of comparison are suggested for the monitoring process: first, actual performance can be judged from the perspective of the direction and magnitude of change over time of the firm itself; secondly, it can be judged in relation to the observed performance of a selected group of competitors; and finally, it can be judged in relation to the assumptions and plans derived from the corporate planning process.

## 8.2 - Delegated Planning and Control

The implications of the analysis for the operational planning, budgeting and monitoring dispersed throughout the organization are not especially fundamental. Established methods of budgeting, performance measurement and variance analysis are already sufficiently powerful from a conceptual standpoint to provide reliable information about internal efficiency and relative movements in the prices and volumes of inputs and outputs.

The advantage of the proposed planning lies in the enhancement of the ability of corporate management to give definitive direction to the organization in its delegated search for opportunities to expand and improve operations. Furthermore, it will enable a more coherent and soundly-based definition of the standards of performance required for the successful implementation of the company's strategies. Bottom-up plans, performance goals and budgets from the firm's organizational units can be definitively appraised against the more aggregate, centrally-derived framework of capital-asset and human resource strategies, integrated into an articulated production strategy for the firm.

## IX CONCLUDING COMMENTS

The paper was initially conceived of as a modest examination of the notion of productivity in an accounting, planning and control context. The outcome is a wide-ranging examination of planning and control systems for the large, complex corporations which have emerged in 20th-century industrial societies. The reason for this is that "productivity" is a chimera; the term means as much or as little as one cares it to mean. Its weightiness as an issue is more a matter of political construction than of definitive econometric or managerial concern. Productivity in a broad sense is simply an attendant condition of sound management, and as such has to be a matter of enduring concern. Current exhortation about productivity

growth, or the lack of it, is more a symptom of the current imbalance between on the one hand peoples' expectations of an ever-growing ability to consume, while simultaneously diverting resources to the accomplishment of social goals, and on the other hand the reality of difficult economic circumstances.

The paper, in adopting a broad perspective on productivity, is arguing the need to construct a total-system, or systemic, framework within which to explore the issue in all its ramifications. The experience-curve algorithm has long been used by companies as a tool for projecting unit costs of production. But its lack of a causal underpinning severely limits its managerial usefulness; it assumes future productivity gains without providing a basis for explaining how these were achieved in the past, or how they are to be gained in the future. The systemic framework seeks to put in place a process which does not assume the experience curve, but rather allows a managerial organization to explore feasible production functions in the light of related cost functions, out of which may emerge cost behavior consistent with the experience curve algorithm. In the course of this, managerial attention should be re-directed in a number of important ways.

First, and most important, instead of concentrating on product-market tactics, using frameworks which are ultimately based on the somewhat dubious notion of product life cycles, managerial attention is directed to a strategic concern for the impact of technology cycles. Technical advance permits the re-defining of the means of satisfying market-place needs through new ways of connecting the organization's capabilities to its customers, and of the way the organization will conduct its work. Without too much danger of exaggeration, it may be claimed that the ultimate strategic concern for the management of an organization is how it will deal with emerging technology, both in terms of its effect on external market

opportunities and in terms of its consequences for the internal functioning of the organization itself.

Secondly, the notion that productivity is roughly synonymous with manufacturing efficiency should be dispelled once and for all. Declining productivity in US industry may just as plausibly be explained in terms of the failure of the marketing function as of the manufacturing function. A firm which produces a product for which there is diminishing demand is unlikely to be productive. And too frequently, one suspects, reliance on the power of selling techniques to move product of declining customer utility out the door has tended to displace the fundamentals of good marketing. The current cry for re-industrialization of the United States is somewhat diffuse in its thrust, but there is a disconcerting sense that it is largely, even solely, based on the notion that greater investment in manufacturing plant and equipment is the key to regaining an edge in international competition. If so, it may contain a mis-directed emphasis, one which could be disproportionate in its influence on the setting of national priorities.

Finally, the systemic framework points to a division of responsibility for productivity between the private sector and the Government. Other than in the conduct of the work of its own agencies, the Government has little direct role to play in the productivity of the economy. There seems good reason to suppose that the Government's concern should be with an equitable distribution of wealth in society, rather than with an active role in wealth creation. But there are very pervasive areas in which the Government can create uncertainties, by unstable policies, which are inimical to private-sector productivity and wealth generation. It is in an identification of these, and a sharing of information about the attendant consequences of uncertainty, that the framework may be helpful in focusing

a constructive dialogue between the Government and the private sector.

The framework, and its supporting methodology, may seem at first sight ponderous. However, accountants will recognize from the debate surrounding the provision of current replacement cost data in corporate financial reports that such a methodology is implied by the FASB requirement. In other words, there is the assumption that companies already have in place the process which can provide, within the limits of the uncertainty surrounding forecasts of the future, valid estimates of future production functions and costs. The proposed framework simply articulates one view of how this can be achieved. It seeks without disregard for positive or normative economic theory, a framework to support management in the task. In philosophy, the proposal is supportive, rather than prescriptive, in its thrust. It is aimed at facilitating a dialectic in the managerial organization, in the spirit of Mason and Mitroff's thesis [26], by which management can articulate, discuss, and finally make informed strategic choices, based on a carefully appraised identification of the underlying strategic assumptions about the forces which will shape the organization's future.



## FOOTNOTES

- 1 Through legislative policies, U.S. energy prices have been for many years uncoupled from world prices; and indeed, even today they are not fully consistent across all fuels. Capital investment undertaken to conserve energy is presumably justified by firms in terms of expected cost savings, and therefore in terms of expected capital productivity. However, the measured returns to this investment are a function of prevailing, rather than expected, prices. Thus, from the perspective of a historical time series the investment may appear to have been relatively unproductive, especially so if management had adopted during the mid- 70's world energy prices as the best predictor of domestic prices. Conceivably, therefore, on this count as well as on the substitution of labor for capital assets, as hypothesized by Jorgenson, U.S. firms individually, and in aggregate, may have lost productivity - both labor and capital productivity - during the 1970's.
- 2 Some readers may take exception to the rather sharp distinction drawn here between government and private-sector economic goals, and the argument is admittedly exaggerated to make the point. In the first place, the argument rests on a distinction between people as workers and people as the owners and investors of financial capital. Nevertheless, it should be borne in mind that such a distinction is commonly made, and is for example formally recognized in tax law by the different treatments of "earned" and "unearned" income. In the second place, it implies that the level and stability of returns to human and financial capital, in the face of stochastic variability in the economy, are potentially negatively correlated. Japanese managerial practice suggests basically that this need not be the case, and it is currently much in vogue in the United States to pose the question "why can't we be more like the Japanese?" Without denying that much can be learned from a critical comparison between one's own economic system and the systems of other countries, it is essentially simplistic to jump to conclusions about the relative competence of U.S. management without also bearing in mind the radical differences in the economic opportunity sets, socio-economic structures, and socio-cultural systems of other countries.
- 3 Carter [9] provides a succinct summary of corporate strategy from a finance perspective. McInnes and Carleton [27] give a review of modeling literature as it applies to strategic financial management.
- 4 For brevity, from this point on the paper simply uses the term "production", or "production function". But this is intended to convey a broad perspective, essentially embracing the total transformation within the firm of inputs to outputs. Thus, included in the meaning is what is commonly thought of as production, but also distribution, administration, engineering and development, and decision making.

- 5 These production units could be under common ownership - e.g., multiple factories within one firm - or they could be independent of one another in terms of ownership - e.g., the firms comprising an industry.
- 6 For convenience, the paper from this point refers to net output, assuming inventory levels to be constant. In such circumstances, net output would be identical to production.
- 7 In explaining differences in measured productivity among production units, these factors, normalized in the measurement process, may well have to be considered explicitly. This is because differences in size and degree of vertical integration may give rise to different production-configuration possibilities to a firm, with resulting differences in actual or potential productivity.
- 8 For example, different categories of labor input could be accommodated by the method. Sherman [31] applies the method to the general medical function of 22 large teaching hospitals, combining multiple inputs and outputs in arriving at a rank ordering of the hospitals in terms of their technical efficiencies.
- 9 Again, the point is stressed that differences in size and vertical integration have been factored out of the measurement. The frontier in Figure 2 is not an isoquant, despite its similarity in appearance to this micro-economic construct. Later in the discussion, possibilities of economies of scale are dealt with.
- 10 Since it will generally not be feasible to work in terms of real outputs and inputs, the analysis will usually be conducted in economic terms. The value added by a firm, as pointed out in Figure 1, is measured by reference to the economic cost of resources consumed to produce output, plus the entrepreneurial profit of the firm. Each component of the input vector could be exactly specified in economic terms by measuring the quantities used and multiplying by market-derived prices. The output vector (sales revenue, plus or minus the inventory adjustment) minus the input vector would then specify the entrepreneurial profit. However, if entrepreneurial profit is present, then the economy cannot be in strict equilibrium, in which case market-prices cannot be unequivocally specified. Thus, strictly speaking, productive efficiency and market effectiveness cannot be "unbundled" in analysing a firm's performance.
- 11 Other aspects of performance would include the efficiency with which materials and purchased services are acquired, and the effectiveness with which products are marketed and priced to customers. Indirectly, financial efficiency - the efficiency of financing investment and operating cash flows - could also be included, since this may affect the cost to the firm of financial capital.
- 12 As will be pointed out later, some adjustment to the accounting data is required to render residual income a more meaningful proxy for economic profit.

- 13 The problem with the PIMS data base in this context is that its data does not relate to firms, but rather to product-market entities. There can be no assurance, therefore, that the internal unit of analysis is comparable with the data in the PIMS data base.
- 14 The corporate planning director of one major corporation recounted that for many years his company had been involved in a major effort to substitute capital for labor in the administrative function, including the planning function. In his estimation the output of the administrative function had been substantially boosted in volume and quality, while labor input had been reduced very significantly.
- 15 This political process could embrace negotiations with a variety of parties - for example, local and Federal Government agencies, unions, suppliers, channels of distribution, and even potential competitors.
- 16 A procedural, rather than non-procedural, language is recommended for the modeling system because of the greater logical discipline demanded by the use of a procedural language. As the structure of the modeling system is discussed, the longer-term advantage of a procedural approach should become clear.
- 17 The economic justification of a "make" versus "buy" strategy for human skills may not of course rest centrally on maintaining a differential, favorable to the firm, between internal and external labor rates. This would ignore the mobility of labor to move from the organization to other opportunities offering more attractive remuneration. Human beings, unlike real property for example, are not assets of the firm in the sense of being contractually owned by the firm. And, even if tied to the firm by some contract, or by some deferred benefit the receipt of which is contingent upon remaining with the firm, the value of a person's service may be affected by the perception of the fairness of the contract. The rationale for the strategy is more likely to lie in the direction of the enhancement of employees' service value - i.e., the enhancement of their productivity. Mobility within the organization still requires learning; a person is unlikely to be immediately productive in a new job to the full extent of his or her potential. But at least the experience of the organization itself is transferable from one job to another. Moreover, a positive motivation to put the organization's welfare high among personal priorities may be reinforced by a "make" strategy, which may in turn translate into enhanced productivity.
- 18 Essentially these conditions allow the production system to be dealt with, for planning purposes, as a single project with infinite life.

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